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(71) Applicant: AEROSOL INVENTIONS AND DEVELOPMENT S.A.A.I.D. S.A.
1, rue de Fries
CH-1700 Fribourg(CH)

(72) Inventor: Perriam, John
237, London Road, Horndean
Portsmouth, Hampshire, P08 0HN(GB)

(74) Representative: Duncan, Angus Henry et al
Barker, Brettell & Duncan 138 Hagley Road
Edgbaston Birmingham, B16 9PW(GB)

(54) Pressurised dispensers.

(57) In a so-called 'aerosol' pressurised dispenser an outlet channel (10), leading to the spraying orifice (12), is smaller in cross-section than hitherto used, being not more than 0.05 square millimetres, and is smaller than any of the restrictions preceding it in the flow path from the interior of the container to atmosphere. This is found to make it possible to obtain satisfactory spraying characteristics, and in particular reasonably constant droplet size, throughout the useful life of the dispenser despite the fall in pressure with use resulting from employing a permanent gas, e.g. nitrogen, as the propellant.

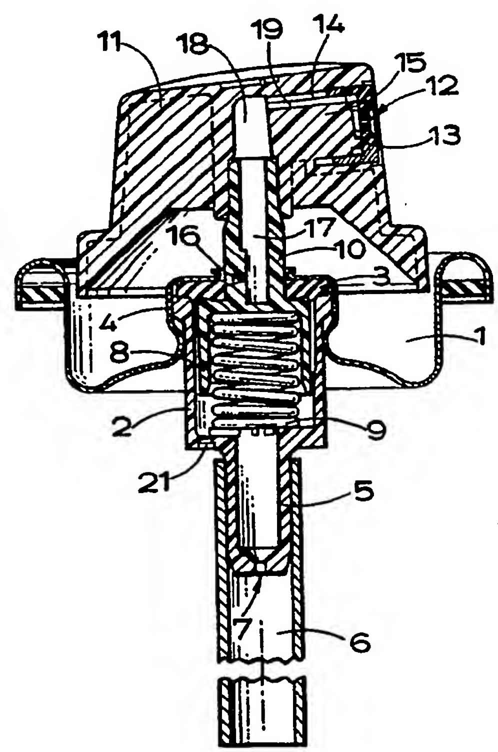

FIG.1.

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PRESSURISED DISPENSERS

This invention relates to pressurised dispensers, in particular to the kind of small hand-held dispenser often colloquially known as an 'aerosol can'. However it is not limited to dispensers which are hand-held, nor to those in which the container is a can.

The aim of such dispensers is usually to produce a spray of fine particles of the product to be dispensed, the cone angle of the spray and the fineness of particles or droplets being dependent on the requirement of the particular purpose and product involved.

The spray head or button of such a dispenser generally employs a nozzle with a swirl chamber to which the mixture of product and propellant is admitted tangentially so that a swirl is imparted to the mixture before it emerges into the atmosphere at a high speed from an orifice on the axis of the chamber and breaks up into a fine spray of predictable particle size.

This is a so-called 'mechanical break-up' system, and examples of nozzles designed for such use are shown in British Patent Specification Nos. 826527 and 845810 of Precision Valve Corporation, 1 018 902 and 1 032 065 of E.H. Green and 1 161 865 of Risdon.

However in practice, using conventional propellants, the break-up into droplets is not caused by any means solely by the swirling action but also by the sudden explosive drop in pressure as the mixture emerges into the atmosphere and, even more important, by the instantaneous evaporation of the propellant, which is a liquid at the pressures prevailing in the can but a gas at atmospheric pressure. Its sudden evaporation blows apart the droplets of the mixture of which it forms part, ensuring the production of a fine spray of particles of relatively consistent size.

The above is true, however, only where the propellant is one of those conventionally used to a wide extent in the past and generally one of the so-called chloro-fluorocarbons (CFC's) or their equivalent, or one of the lower hydrocarbons such as butane or propane which, like CFC's, are liquid at the pressure prevailing in a pressurised dispenser at normal temperatures but gaseous liquid at atmospheric pressures. For environmental reasons there is now a strong move away from CFC's, and the use of hydrocarbons has its drawbacks in many situations as they are flammable.

The great advantage of these non-permanent gases in pressurised dispensers has been that the pressure in the container remains constant throughout its useful life; there is liquid propellant mixed with the product filling the greater part of the can when it is new, with an atmosphere of gaseous propellant above it. As the product and propellant are used up the liquid level falls but more propellant evaporates into the gas space above and the pressure remains unchanged, governed only by the temperature at which the can is stored.

For the environmental reasons mentioned above strenuous efforts have been made for a number of years to get away from the CFC's and hydrocarbons, and a lot of work has been put into substituting other materials, mainly the permanent gases such as carbon dioxide, nitrous oxide, nitrogen and even air. Carbon dioxide has its own problems in that it is now environmentally suspect, and although its slight solubility (with difficulty) in some products does give it the advantage that it does to some degree try to maintain pressure by evaporation into the gas space as the liquid level falls, this effect is strictly limited. Nitrous oxide is expensive. Air is unsatisfactory with most products because the oxygen in the air may, over the long period which an aerosol can may be on the shelf before use, attack components in the product. Nitrogen is ideal from this aspect, being almost totally inert, but like air and other permanent gases it suffers from the very serious drawback that the pressure in the container falls continuously and exponentially throughout the useful life of the dispenser.

The amount of the fall will depend on the proportions of gas and of product initially in the container. If there is to a reasonable and useful amount of product present to be dispensed then in a typical case the pressure might fall from 9 bar when the dispenser is new to 3 bar or even less by the time 95% of the product has been dispensed.

The position is further aggravated if the user inadvertently, or through not realising the problem, tilts the container and tries to dispense in a position in which the lower end of the dip tube is momentarily uncovered by liquid. Where the propellant is a permanent gas this can result in a direct and rapid loss of pressure, in contrast to a dispenser of the earlier kind, where there is a margin of surplus propellant and where, unless the uncovering is prolonged, the pressure is restored by additional evaporation of propellant from the liquid.

However the main drawback of the fall in pressure using permanent gases is the behaviour of the spray nozzle. Such nozzles are designed for spraying at a given pressure, or at least at pressures within a certain limited range. As the pressure falls not only does the rate of delivery fall but also the spray pattern changes and the droplet size becomes much coarser so that, for example in the

case of body sprays, there is an increase in the perceived wetness of the product in contact with the skin.

Manufacturers of pressurised dispensers and of valves for them are well aware of this problem and many attempts have been made in recent years to overcome it by the use of some kind of compensator. These attempts have mainly have directed to the provision of spring-loaded pressure-reducing valves mounted somewhere in the path of the product from the interior of the container to the dispensing orifice, usually in the spray tip or button itself. In one known arrangement, there is initially a substantial pressure drop in the reducing valve but as the pressure in the container falls a spring moves a piston-like valve member back and the reduction is less, so that the pressure at the nozzle orifice is kept approximately constant. In another, instead of a piston and spring, a resilient disc acts as a combined valve member and spring.

In a third known proposal the reducing valve is made of rubber and again acts as a combined valve member and spring; it is mounted not in the nozzle but in the valve housing, at an earlier point in the flow path, but again the purpose is to introduce a pressure drop which itself falls as the pressure in the container falls.

It will be evident that these solutions, especially those involving sliding spring-backed pistons, are not only expensive to produce but are moreover likely to be uncertain in operation after a substantial shelf life. Other solutions have involved a capillary dip tube or a restricted tail piece ('RTP') on the valve housing to restrict flow and introduce a pressure drop.

All such solutions involving a deliberately introduced pressure drop well ahead of the final nozzle orifice are furthermore in effect throwing away the advantage of the initial available pressure, and the nozzle has to be designed for a relatively low pressure, which restricts the ability to produce a fine spray and a good spray pattern.

The aim of the present invention is therefore to provide a way of achieving a sufficiently consistent fine spray and good spray pattern throughout the useful life of a pressurised dispenser, yet a low cost and without the use of moving parts.

According to the invention we achieve this simply by using, in the final nozzle leading to atmosphere, a restricted number of channels of significantly smaller total cross-section than used hitherto, in conjunction with a final orifice of a diameter smaller than those used hitherto, this final orifice and channel or channels being the predominant restriction in the flow path from the interior of the container to atmosphere, that is to say, being of smaller cross-section than the dip tube and of any internal metering orifice (IMO) in the valve housing or valve member.

Unexpectedly, as the examples which follow will show, this makes it possible to achieve an acceptably constant flow rate and droplet size over a pressure range of as much as three to one or even more.

In a preferred embodiment there are two tangential channels, or only one, leading into a swirl chamber behind the final orifice and the or each channel is not more than 250 micrometres wide by 175 micrometres wide. The final orifice itself is between 150 and 200 micrometres in diameter. It has been found that, using the conventional water-based or alcohol-based products in conjunction with a nitrogen or carbon dioxide propellant, such a nozzle can produce a more than satisfactory spray pattern and droplet size when the pressure in the container falls from 9 bar to $2\frac{1}{2}$ bar.

It is believed that one factor contributing to this unexpected result is that the main pressure drop which controls the rate of flow is concentrated at the nozzle, i.e. the flow rate is not influenced by any internal metering orifice (IMO) or restricted tailpiece (RTP) at an earlier point in the flow.

The delivery rate inevitably falls to some extent as the pressure falls, and indeed there is also some increase in the droplet size, but a compensating factor which has been observed is that at a lower flow rate a small increase in particle size gives no increase in perceived wetness (e.g. in a body spray).

In a typical case the initial delivery rate may be of the order of 0.6 gm/second, falling perhaps to 0.45 gm/sec towards the end of the life of the dispenser.

The invention will now be further described by way of example with reference to the accompanying drawings, in which:-

<u>Figure 1</u> is a cross-section through a typical valve assembly for a pressurised dispenser;

<u>Figure 2</u> is a section through a portion of the spray tip or button of an assembly similar to that of Figure 1, showing the spray nozzle or insert;

<u>Figure 3</u> shows a section through the insert alone, and constructed in accordance with the invention;

<u>Figure 4</u> is a view of the insert of Figure 3 looking axially at its rear face;

<u>Figure 5</u> is a view similar to Figure 4 but showing an alternative form of insert;

<u>Figure 6</u> is a graph showing the result of a test using the insert of Figures 3 and 4 and indicating the fall in pressure with use;

<u>Figure 7</u> is a graph showing the fall in discharge rate with use;

<u>Figure 8</u> is a graph showing the change in medium particle size as the contents of the dispenser are used up;

Figure 9 is a combined graph and histogram illustrating the particle size distribution in the spray obtained from the insert of Figure 5 at a given discharge rate; and

Figures 10 and 11 correspond to Figure 9 but shows the particle size distribution at different pressures.

Referring first to Figure 1, a typical valve assembly for a hand-held pressurised dispenser comprises a mounting cup 1 (for mounting as a standard 'one-inch' opening in a container) supporting a valve housing 2 which traps a gasket 3 against the top wall of the centre boss 4 of the mounting cap. A tail 5 on the lower end of the housing 2 receives a flexible dip tube 6 which extended down to near the bottom end of the container in use. The tail has a restricted entry (RTP) at 7.

Within the housing 2 is a valve member 8 urged against the gasket 3 by a spring 9 and having a central stem 10 which extends up through the gasket to receive an actuating button or spray tip 11. An outlet orifice for the product to be dispensed is formed at 12 in a cup-shaped insert 13 which is force-fitted into a recess 14 in the button, simultaneously fitting over a central post 15 of the button.

A small radial hole 16 leading into a central passage 17 in the stem 10 is covered by the gasket 3 in the rest position of the valve but when the button is depressed, carrying the valve member downwards with it, the liquid product in the container, under the pressure of the propellant gas also present in the container, is forced up the dip tube 6, though the housing and the hole 16 into the passage 17 and through passages 18 and 19 in the button 11 to the insert 13 to emerge as a spray through the orifice 12.

All that has been described so far is well known. The passage 19 in the button leads into four tangential channels which are defined between the back of the insert 13 and the face of the post 15 to converge on a swirl chamber from which the product passes through the orifice 12 with a swirling action. This is what achieves the so-called mechanical break-up.

The heart of the present invention lies in a novel construction of the channels (there may only be one) and the orifice. For this we refer to Figures 3 and 4. Instead of four tangential channels we have only a single one, shown at 20 in Figure 4, formed by a groove in the back of the insert and having an axial depth of between 150 and 200 micrometres. The width is the same. Thus the cross-sectional area is between 0.0225 and 0.04 square millimetres. The back wall of the channel is formed by the end face of the post. The length is of the order of 1mm, but will depend on the diameter of the post and the diameter of the swirl chamber, shown at 21. The orifice 12 has a diameter of between 200 and 250 micrometres giving it a cross-sectional area of between 0.003 and 0.05 square millimetres, i.e. a mean value rather greater than the cross-sectional area of the channel 20. Thus it is the channel 20, immediately preceding the orifice 12, which is the governing restriction in the flow path between the interior of the container and atmosphere. This cross-section is significantly smaller than any other ahead of it in the flow path, in particular it is smaller than the radial hole (IMO) 16 in the stem and the restriction (RTP) 7 at the inlet to the housing 2. Generally speaking, each of these last-mentioned holes will be at least 450 micrometres in diameter.

Both the channel size and the size of the orifice 12 are believed to be substantially below those hitherto ever used in production in the nozzles of pressurised dispensers. The axial length of the orifice 12 in the example shown is 150 micrometres, i.e. rather less than its diameter, whereas the figures above show that in the case of the channel 20 the length is five or six times the width. Generally speaking it should be at least four times the width.

We are not limited to there being only a single channel. Figure 5 shows an insert with two tangential channels 20 and 20′. They are each of the same dimensions as the single channel 20 of Figures 3 and 4, and allow an increased flow rate, although with an orifice 12 of the same size as before the flow rate is by no means doubled. In practice we prefer to use not more than two channels.

The remaining Figures are graphs and histograms illustrating test results obtained with the arrangement according to the invention. Figure 6 shows how, with a typical hand-held pressurised dispenser fitted with the valve assembly described and using nitrogen as the propellant gas, the pressure inside the container may fall from an initial pressure of 9 bar when the container is new to as little as $2\frac{1}{2}$ bar when 95% of the useful contents have been dispensed. With the known nozzles, in the absence of any compensator, this would result in a very poor spray pattern and very large droplets towards the end of the useful life of the dispenser, and possibly even dribbling rather than spraying.

As shown in Figure 7, however, it will be seen that, using the nozzle described, the discharge rate (with the valve fully open) falls from an initial 0.56 gm per second in a typical case down to 0.36 gm per second, a fall of only 35% over this period. Moreover, as shown in Figures 8, 9, 10 and 11, the mean particle size increases only slightly as the pressure falls, and the distribution of particle sizes does not change significantly at all. Figures 9, 10

and 11 have a logarithmic horizontal axis. It will be seen that, when the pressure in the container was 9 bar (Figure 9), the predominant particle size was about 50 micrometres, fifty per cent of them being of this size or smaller and the discharge rate was measured at 0.64 gm/sec. When, as shown in the graph of Figure 10, the pressure had fallen to 4.9 bar and the discharge rate to 0.44 gm/sec, the mean particle size had shifted only slightly. Figure 11 shows the position when the pressure had fallen to 3.2 bar and it will be seen that the predominant particle size is still only between 60 and 70 micrometres. The discharge rate has fallen to 0.34 gm/sec and, as mentioned above, the perceived wetness on the human skin is no greater for a larger particle size where at the same time the rate of delivery onto the skin has fallen.

Figure 8 is a graph obtained from a repeated series of tests like those of Figures 9, 10 and 11, and it will be seen that the median particle size only increased from about 41 micrometres to about 60 micrometres as the amount of the product in the dispenser fell from an initial 100% of the full charge down to 5%, ie. after 95% of the contents had been dispensed.

All in all, the above test results show that the use of the fine channel or channels in the nozzle of the spray button, representing the dominant restrictions in the flow path and of dimensions significantly smaller than those used hitherto, has achieved an acceptable spray quality throughout the useful life of the dispenser when using a permanent gas as the propellant, yet without having to resort to expensive and unreliable compensating devices. It is believed that this represents an important and unexpected break through which advances substantially the ability to switch to non-CFC and non-hydracarbon propellants without significant detriment to the acceptability of aerosols.

Whilst the above test results are those using nitrogen or air, similar results are obtainable with nitrous oxide, and if carbon dioxide is used even better results are obtained in the case of some products, by virtue of its partial solubility in many mixtures.

Without departing from the invention one could provide a so-called 'vapour tap' of a known kind in the valve housing, as indicated at 21 in Figure 1, and this could be as small as, or even smaller than, the channels 20 but it is only in the path of the gas, not the path of the liquid product.

In the example described the or each channel is formed in the back of a moulded insert, made for example from acetal resin. However it will be understood that the particular geometrical layout shown is by no means essential, and in practice the channels could be formed in another way, for example in the top of the post onto which the insert is pressed, or, as in some known spray buttons, one could dispense with a separate insert altogether and make the spray button in one piece, complete with channels and final orifice, although this could be very difficult to mould, bearing in mind the very small cross-sections involved.

Moreover, for small discharge rates, for example in handbag size mini-dispensers for perfume, even smaller dimensions than those specified may be used.

Claims

1. A pressurised dispenser comprising a container fitted with a manually operated valve assembly equipped with a dip tube and having a spray tip (11) with at least one outlet channel (20) leading to a spraying orifice (12) designed to produce a spray of droplets of a liquid product from within the container under the action of a compressed gas propellant, in which the propellant gas is a permanent gas, distinguished by the feature that the cross-section of the or each channel (20) leading to the orifice (12) is smaller than that of any other restrictions preceding it in the flow path from the interior of the container to the orifice (12) and is not greater than 0.05 square millimetres.

2. A pressurised dispenser according to claim 1 in which the said cross-section is not greater than 0.04 square millimetres.

3. A pressurised dispenser according to claim 2 in which the said cross-section is not greater than 0.03 square millimetres.

4. A pressurised dispenser according to claim 1 in which the said cross-section lies between 0.0225 and 0.04 square millimetres.

5. A pressurised dispenser according to any one of claims 1 to 4 in which there are not more than two such channels (20,20').

6. A pressurised dispenser according to claim 5 in which there is only one such channel (20).

7. A pressurised dispenser according to any one of claims 1 to 6 in which the or each channel (20) has a length which is at least four times its mean width.

8. A pressurised dispenser according to any one of claims 1 to 7 in which the or each channel (20) is directed tangentially into a swirl chamber which leads to the spraying orifice (12).

9. A pressurised dispenser according to any one of claims 1 to 8 in which the spraying orifice (12) is round and has a diameter which is not greater than 250 micrometres.

10. A pressurised dispenser according to claim 9 in which the diameter of the spraying orifice (12) is substantially 200 micrometres.

11. A pressurised dispenser according to claim 9 or claim 10 in which the length of the orifice (12) is

less than its diameter.

12. A pressurised dispenser according to any one of claims 1 to 11 in which the pressure in the container is initially of the order of 9 bar and falls to around 3 bar by the time 95% of the product within it has been dispensed.

13. A spray tip assembly for a pressurised dispenser according to claim 1 having at least one outlet channel (20) leading to a spraying orifice (12) designed to produce a spray of droplets, in which the cross-section of the or each channel (20) is not greater than 0.05 square millimetres.

14. An insert for fitting to a spray tip (11) to form a spray tip assembly according to claim 13 and having a spraying orifice (12) and, leading to it, at least one groove designed (20) to co-operate with a face on the spray tip (11) to form the or each said channel, the groove having a width and depth not exceeding 220 micrometres.

15. An insert according to claim 14 in which the groove (20) has a length at least four times its width.

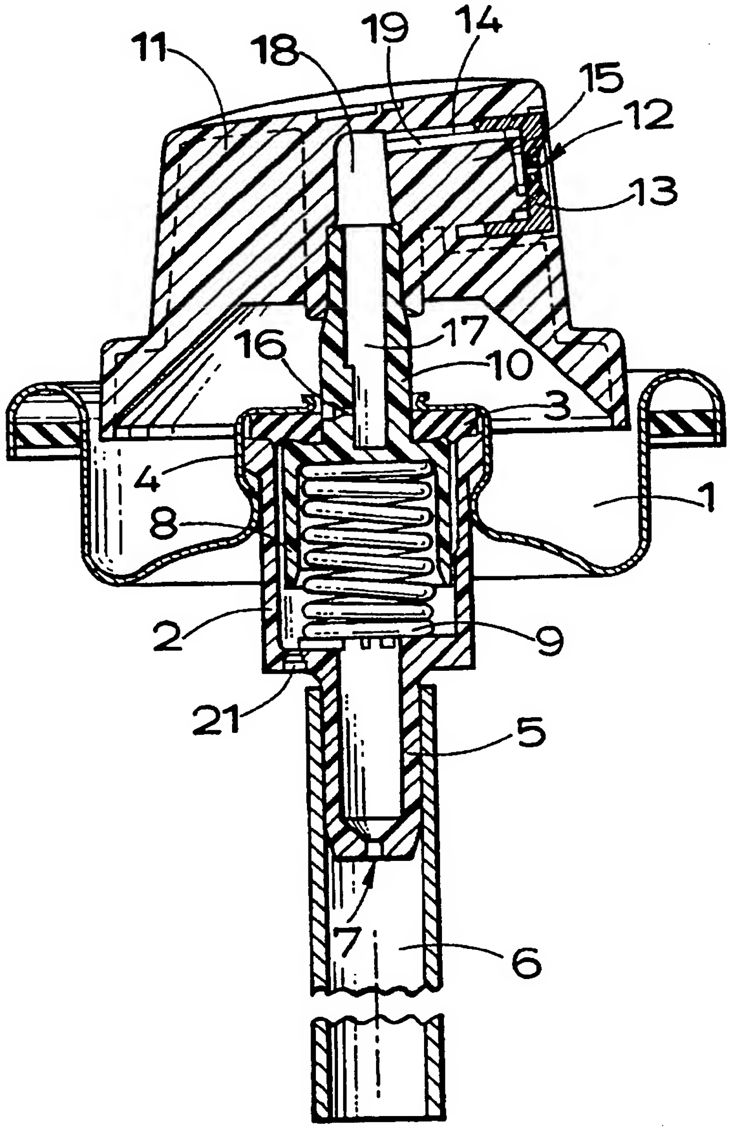

FIG.1.

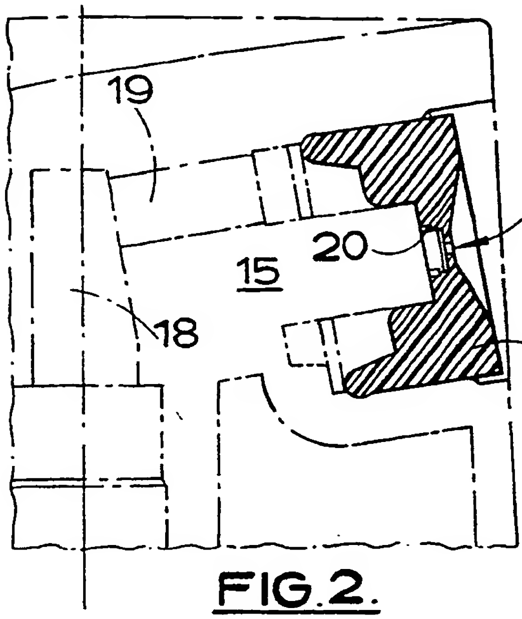

FIG.2.

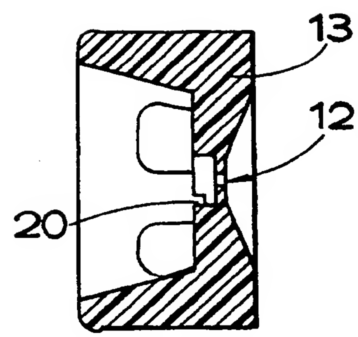

FIG.3.

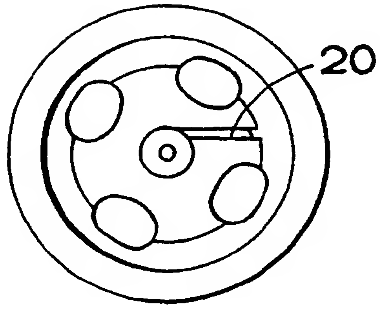

FIG.4.

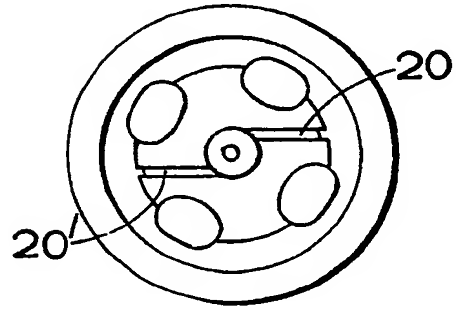

FIG.5.

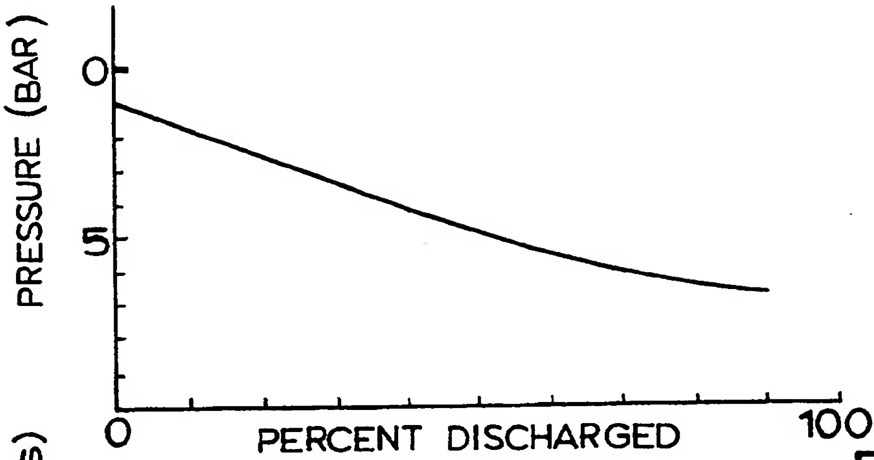

FIG.6.

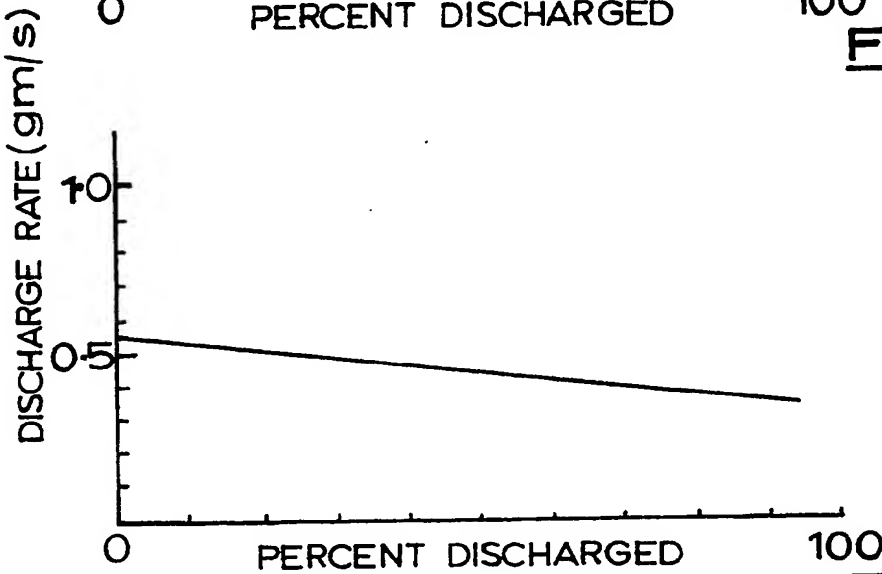

FIG.7.

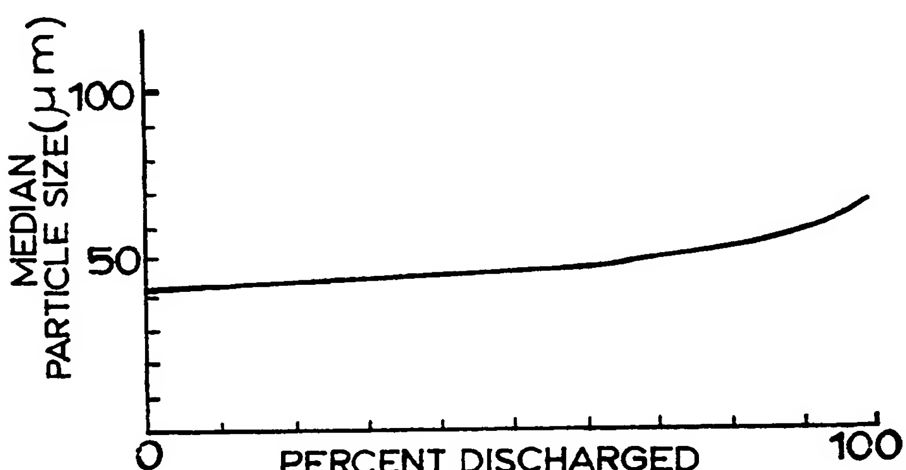

FIG.8.

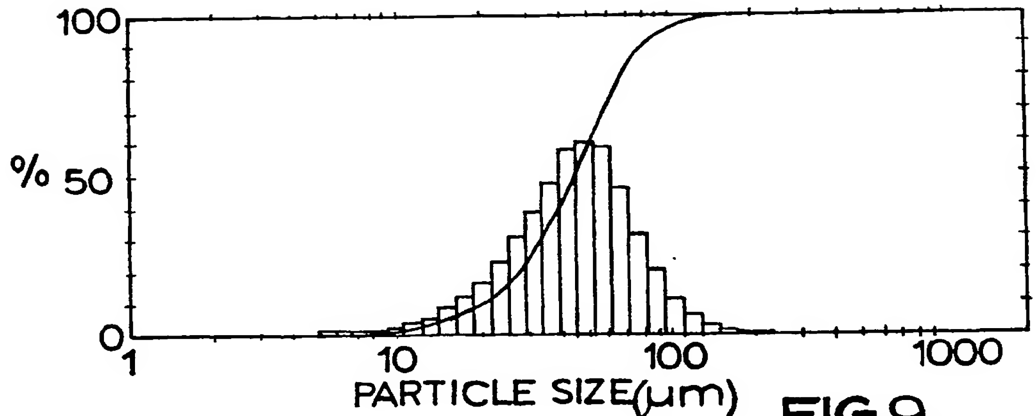

FIG.9.

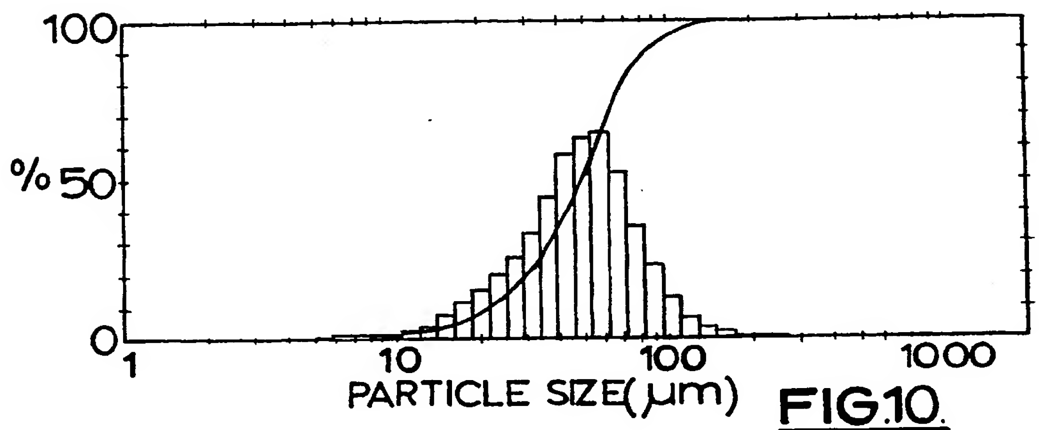

FIG.10.

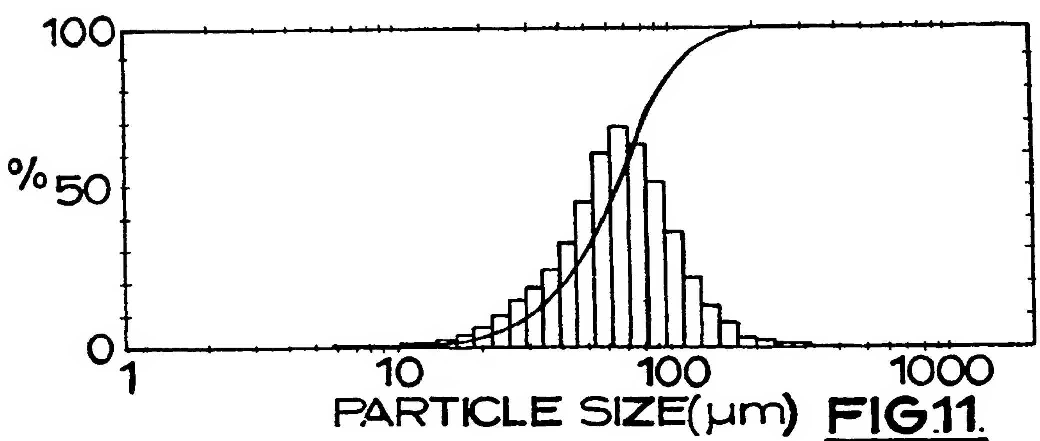

FIG.11.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 31 0406

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4071196 (BURKE ET AL.) * column 1, lines 7 - 39; figures 2, 8 *	1, 8, 12	B65D83/14
A	DE-C-1118708 (THE RISDON MANUFACTURING COMP.) * column 6, lines 3 - 29; figures 1-3 *	1, 2, 8, 13, 14	
A	GB-A-1048028 (GREEN) * page 1, line 76 - page 2, line 30; figures 1, 2, 9 *	1, 8	
A	US-A-3240431 (HUG ET AL.) * column 4, line 73 - column 5, line 33; figures 1-4 *	1, 5, 6, 8	
A	US-A-3120348 (O'DONNELL) * figure 3 *	7, 8	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	14 DECEMBER 1990	SPETTEL, J.D.M.L.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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